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(54) Oscillatory and/or Reverberatory Solid for Instruments and Devices for Generation,
Emission, Distribution or Transmission of Sound Vibrations

Claims

1. Oscillatory and/or reverberatory solid for instrument and devices for generation, emission, distribution or transmission of sound vibrations, having a structure of spatial distribution of its vibration parameters at least in sections, characterized by the fact that the spatial structure (G, G1, G2, ...) of vibration parameters has at least two superimposed, essentially equidistant sequences (R, R1, R2, ...) of regions of increased or reduced deformation rigidity, oscillation weight, vibration damping, surface curvature or camber and/or reflectivity or absorptivity.
2. Solid according to Claim 1, characterized by the fact that the distances (D1, D2, D3, ...) of at least one part of the equidistant structure sequences are in an at least roughly whole-number ratio to each other, preferably corresponding to the values of a geometric series.
3. Solid according to Claim 1 or 2, characterized by the fact that the variation amplitudes (AE) of the vibration parameters are designed to increase or diminish from superimposed sequence to superimposed sequence and/or within each superimposed sequence at least in sections.
4. Solid according to one of the preceding Claims, characterized by the fact that at least one superimposed structure (G3, G4) is formed by at least a family of elongated, adjacent regions with different values of at least one vibration parameter with reference to their surroundings and that these regions form at least two equidistant superimposed sequences (R1, R2, R3, ...) with their mutual distances.
5. Solid according to Claim 4, characterized by at least two intersecting families of elongated regions with different values of at least one vibration parameter with reference to their surroundings.
6. Solid according to one of the preceding Claims, characterized by the fact that at least one superimposed structure (G5) is formed by regions bounded essentially on all sides in at least one plane with different values of at least one vibration parameter with reference to their surroundings.

7. Solid according to Claim 6, characterized by the fact that the regions of different vibration parameters are distributed in rows or grid-like in at least one surface.
8. Solid according to one of the preceding Claims, characterized by the fact that at least one superimposed structure (G2) extending along a protruding edge (K) is provided.
9. Solid according to one of the preceding Claims, characterized by the fact that at least one superimposed structure (G3), especially two-dimensional, extending along one surface of the solid is provided.
10. Solid according to Claim 9, characterized by the fact that at least one cavity is provided whose inside wall surface has at least one superimposed structure (G14, G16).
11. Solid according to one of the preceding Claims, characterized by the fact that at least one superimposed structure is formed by elevations, especially rib-like or wave-like and cup-like elevations within a solid surface.
12. Solid according to Claim 11, characterized by the fact that the elevations of the superimposed structure are formed at least partially by mounted elements in the region of a solid surface.
13. Solid according to one of the preceding Claims, characterized by the fact that at least one superimposed structure is formed by embedded elements within the solid base material.
14. Solid according to one of the Claims 11 to 13, characterized by the fact that the mounted or embedded elements consist of a material different from the base material of the solid, especially one of higher density, preferably heavy metal.
15. Solid according to one of the preceding Claims, characterized by the fact that at least one preferably two-dimensional superimposed structure is formed by at least one surface layer or at least one layer section, especially in the form of a granulate, paint and/or film coating, preferably with metal content.
16. Solid according to one of the preceding Claims, characterized by the fact that at least one superimposed structure is formed by indentations, especially notches, depressions or openings.

17. Solid according to one of the preceding Claims, characterized by an at least partially rib-like, web-like, bar-like, plate-like or membrane-like design with at least one superimposed structure extending along the solid surface.

18. Solid according to one of the preceding Claims, characterized by an at least partially rib-like, web-like, bar-like or plate-like design with at least one superimposed structure extending along a solid edge and especially encompassing the edge profile.

19. Solid according to one of the preceding Claims, characterized by an at least partially hollow design with at least one superimposed structure extending along an inside wall surface of the hollow element.

20. Solid according to Claim 19, characterized by an at least partially tube-like design with interior superimposed structure extending especially in the longitudinal direction of the tube.

21. Solid according to Claim 17 or 18, characterized by a design as a vibrating or resonance plate or housing of a musical instrument, especially a string instrument.

22. Solid according to Claim 17 or 18, characterized by a design as a stiffening rib, support bar, a tuning bar, string bow, string bridge or tailpiece for a string instrument with at least surface one and/or edge superimposed structure.

23. Solid according to Claim 19, characterized by a design as a hollow resonance body for string instruments, especially bowed string instruments.

24. Solid according to Claim 20, characterized by a design as a tube of a wind instrument, especially with at least one superimposed structure extending in the longitudinal direction of the tube.

25. Solid according to Claim 17, characterized by a design as a loudspeaker membrane.

26. Solid according to Claim 19, characterized by a design as a sound distribution space, especially a concert hall, with at least one inside surface superimposed structure, preferably with superimposed sequences of convex or concave surface elements.

27. Solid according to Claim 3 or according to this and at least one the other preceding Claims, characterized by the fact that the variation amplitudes (AE) and at least

one vibration parameter, especially bending rigidity or cross sectional height of the stiffening ribs is designed diminishing from the middle region of the superimposed structures to their end regions.

28. Solid according to Claim 4 or according to this and at least one of the other preceding Claims, characterized by the fact that the distances between the elongated, adjacent regions of different vibration parameter values with reference to their surroundings are designed variable over the family in the longitudinal direction of these regions (Figure 12).

29. Solid according to Claim 28, characterized by the fact that the elongated regions of different vibration parameter values with reference to their surroundings are designed adapted in longitudinal trend to the adjacent edge contour of a surface section of the oscillatory solid (Figure 12).

The invention concerns a solid of the aforementioned type with the characteristics according to the principal clause of Claim 1. Elements and assemblies of musical instruments, like soundboards, as well as vibrating or resonance cavities, especially sound boxes, but also stiffening ribs, for example, bass bars, support rods, especially tuning bars, string bows, string bridges, as well as tailpieces (the latter for string instruments), but also sound emission and sound generation elements driven by electric motors, like loudspeaker membranes, fall under this generic definition. It is functionally common to these elements or assemblies that the solid vibrations are generally designed in thin-walled, elastically deformable regions in the form of standing waves with a vibration direction across or at an angle to the solid surface, which is often effective as a sound emission or transmission surface.

An essentially different class of solids for sound generation and emission that also belongs to the type of the invention, are hollow elements, especially tubular ones within which standing air vibrations are formed and indeed in tubular elements of a wide variety of types, as are used for wind instruments with a longitudinal direction of vibration essentially in the longitudinal direction of the tube. The solid with its cavity configuration and its cavity

dimensions then determines the sound spectrum, but need not necessarily participate itself in the vibration.

Another class of hollow elements within the type of the invention are sound distribution spaces, like concert halls and the like, which themselves do not essentially participate in the vibration and in which no standing waves are formed either, but which determine the sound pattern perceptible in the space by their cavity configuration and cavity dimensions, as well as by the material properties with respect to reflectivity and absorptivity of the inside wall surfaces.

With reference to the extensive generic concept just explained the invention pursues the task of permitting targeted influencing of spectral composition, especially the sounds that are distributed in the space by formation or emission, thus permitting an aesthetic improvement of the sound pattern or suppression of distorting effects. The solution to this task according to the invention is defined in conjunction with the stated generic characteristics by the characterizing features of Claim 1.

As studies have shown, a surprising improvement in the generally desired sound properties, especially sound volume and inertia and disturbance-free and equalized sound propagation are made possible by the stated superimposed structures whose production essentially requires only fulfillment of additional configuration and dimensional criteria, but no additional construction expense.

In the first named class of sound solids with standing transverse waves that are converted on the solid surface to propagating longitudinal waves in the air space the sound effect occurs essentially by nonuniform spatial, i.e., one- to three-dimensional distribution of elastic deformation rigidity or by a complementary weight distribution according to the stated superimposed structure. In this fashion the formation of nodes or antinodes in the sense of a sought spectral or harmonic distribution is favored. In the second named class formation of the standing longitudinal waves is influenced directly in the air filling of the cavity with its nodes and antinodes in the sense of a desired spectral distribution by deliberate distribution of the narrow and broad sites over the tube length, in principle without vibrations of the actual solid. For hollow elements of the third class neither solid vibrations nor standing

waves play an essential role, but instead the spectral distribution is influenced by the reflectivity or absorptivity in the sense of disturbance-free sound propagation. In all cases a targeted spectral effect is applied by means of superimposed structures.

An essential modification of the invention led to dimensioning of the superimposed, equidistant structure sequences in a manner so that the distances of the sequences, i.e., the mutual spacings of the regions of increased or reduced deformation rigidity or oscillating mass are in a whole-number ratio to each other within a sequence and form a harmonic series especially in a larger number of superimposed sequences. This primarily leads to a noticeable improvement in sound purity and a reduction of the distortion factor.

The invention is further explained with reference to the practical examples schematically depicted in the drawing. In the drawing:

Figure 1 shows a profile of a rib-like vibration element provided with superimposed structure,

Figure 2 shows a front view of a violin bridge as a vibrating element provided with edge superimposed structure,

Figure 3 shows a perspective partial section of a soundboard provided with superimposed structure,

Figure 4 shows a top view of an oscillating solid surface with schematically indicated multiple superimposed structure,

Figure 5 shows a schematic two-dimensional top view of a vibrating element surface with regions of different weight occupancy distributed in grid-like fashion,

Figure 6 shows a simplified cross section of a plate-like vibrating element with different added elements, as well as openings to influence oscillating weight occupancy,

Figure 7 shows a partial side view of a rod-like vibrating element with superimposed structure,

Figure 8 shows the cross section of a stiffening rib with two-dimensional superimposed structure extending over the rib periphery,

Figure 9 shows the cross section of a stiffening rib with embedded material of higher density distributed according to superimposed structures,

Figure 10 shows the contour trend of an arc-shaped stiffening rib with dimensioning of the cross-sectional height over the rib length according to a superimposed structure,

Figure 11 shows an arrangement of stiffening ribs distributed over a resonance plate with a cross-sectional height distribution over the rib number corresponding to a superimposed structure,

Figure 12 shows a two-dimensional distribution of stiffening ribs in two intersecting families, partially with a curved trend on the soundboard of a string instrument with distance dimensions corresponding to two superimposed structures,

Figure 13 shows a top view of a loudspeaker membrane with radial and circular, linear stiffening or weighting elements and spatial dimensioning according to the corresponding superimposed structures,

Figure 14 shows a wind instrument tube in longitudinal section with nonuniform cross-sectional dimensioning over the tube length corresponding to a superimposed structure,

Figure 15 shows the harmonic distribution of longitudinal standing waves produced in the tube according to the superimposed structure and

Figure 16 shows a schematic view of a height-width cross-sectional configuration of a concert hall with inside wall profiling corresponding to a superimposed structure.

A stiffening rib connected slide-proof to a soundboard RB in the form of an elongated vibrating element SE is shown in Figure 1. This type of element can find broad application, for example, in the form of a bass bar in the usual manner. In addition to its static support function to reinforce the soundboard against the string tension, this element as a component of the overall vibrating body has a significant effect on the resonance spectrum and transient behavior, on the tone color and playability of the string instrument.

Whereas an evenly suspended longitudinal profile form that tapers toward the ends of the bar is generally common to such stiffening ribs and an essentially uniform structure by equidistant profile height reductions over the bar length is used according to the modifications mentioned in the introduction with significant effects, in the present case a structure G of the longitudinal profile that consists of additive superposition of four equidistant sequences R1 to R4 with respect to profile height, distributed unevenly over the

bar length, is provided. Each of these sequences contains regions A1 or A2 or A3 or A4 of increased bending-deformation rigidity, as well as regions B1 or B2, etc. of reduced bending-deformation rigidity arranged in alternation with the latter. Greater oscillating mass occupancy is also present in the stiffened regions owing to the greater bar cross section to the extent that compensation or even overcompensation of this weight increase is not carried out by additional measures (perhaps a reduction in profile width or a reduction of cross-sectional area in the center region of the cross-sectional height, for example, in the form of recesses or openings).

The vibration pattern of a resonant element generally consists of a multiple overlap of standing waves of different wavelength and amplitude. A limited or attenuating elastic bending deformation then prevails in the node regions and maximum bending deformation in the antinode regions. As a result, the formation of vibration nodes or vibration antinodes is favored in the regions of increased or reduced bending rigidity. Whereas a simple, equidistant distribution of regions of increased and reduced rigidity now favors formation of a standing wave concentrated in the region of a resonance frequency so that certain sought tones are already attainable within the resonance spectrum, overlapping of different equidistant sequences of regions of increased and reduced rigidity permits emphasis of a corresponding frequency band. This means the possibility of a significantly improved configuration of tone pattern in its balance and variety.

The regions of the resonance spectrum in which emphasis appears can be deliberately and reproducibly adjusted by selecting the distance values D1, D2, etc. (see Figure 1) of the superimposed sequences and their mutual ratio. In the interest of a balanced spectral trend and deliberate adjustment of continuous transitions the rigidity differences within the individual sequences can be dimensioned differently, advantageously in a manner so that the differences from sequence to sequence are graded in the same direction as the distance value. This type of arrangement is shown in Figure 1 by the profile contour depicted in a solid line. The partial contours of sequences R1 and R2 are indicated with dashed lines. On the other hand, the rigidity differences can also be varied within each sequence in the interest of particularly soft transitions, perhaps in a manner so that it diminishes to both sides from a

center point of the vibrating element or a section of the vibrating element. A structure G1 as shown with the dash-dot line in Figure 1 then results.

Dimensioning of the distances D1, D2, ... according to whole-number ratios is essential for the generally sought sound purity. This condition is also expediently maintained in a limited number of superimposed sequences. For more extensive overlap dimensioning of the distances D1, D2, D3, ... according to a harmonic series is recommended, i.e., according to a length subdivision of a vibrating element section in a 1/2, 1/3, 1/4 ratio, etc. Excellent effects with respect to sound fullness and sound purity are then obtained, especially in string instruments.

Figure 2 shows the use of the mentioned structure on a plate-like vibrating element, namely a string-carrying bridge of a string instrument, in which a structure G1 of the type depicted in Figure 1 extends along an edge K of the bridge. Additional, shortened structures G2 are applied on the side edge sections KS of bridge ST, which is effective as a multiple-structure vibrating body with the vibrating elements SE1 on the edge K, as well as SE2 on the side edges KS. For this application a practically established, rather high sound effectiveness even by comparatively weakly pronounced structures is indicated. This should be attributed to the frequency-selective coupling effect of the bridge between the sound-generating strings and the hollow resonance elements of the instrument body, in addition to pronounced participation in direct sound emission.

Figure 3 shows a plate-like vibrating element SE2 with superimposed structure G3 on both surface sides. These structures correspond in cross-sectional profile to the already explained edge superimposed structure G according to Figure 1. The regions of increased or reduced bending rigidity form a family of adjacent, elongated ridges or troughs that form the superimposed sequences of the explained type across their longitudinal direction. Such variants are considered with a rather high overall effect for soundboards of a wide variety of types, especially for soundboards or plates in mechanized plucked string instruments and for the moving elements of resonance cavities for strings, especially for bowed string instruments.

Figure 4 schematically depicts the possibility of a further refined surface superimposed structure, namely in the form of two families of crest-like regions A1, A2, A3 of increased bending rigidity intersecting on a surface side of a plate-like vibrating element SE3 and forming two superimposed structures G3 and G4 of the type in Figure 3. Trough-like surface regions of reduced bending rigidity are produced between the crest-like regions but are not numbered in the interest of clarity. Structures of this type permit a targeted effect on the two-dimensional standing wave pattern and are considered with greater effectiveness especially for more extensive resonance patterns.

When sites with particularly limited remaining cross-sectional thickness are to be avoided in thin-walled plate resonators, the intersecting arrangement of a crest-trough structure on both surface sides of the plate is recommended.

Corresponding structure effects can also be achieved in principle by means of nonuniform distribution, especially in plate resonators. Assuming a uniform distribution of deformation rigidity, preferred positions of the wave nodes and wave antinodes are then reversed, i.e., wave antinodes are preferably produced in the region of increased oscillating mass and wave nodes in the region of reduced oscillating mass. It goes without saying that the edge or tension conditions of the oscillating element section must be compatible with this layout, which also holds in analogous fashion for the rigidity structures. With these conditions in mind, combined rigidity and weight structures are advantageously applicable. At any rate, as already mentioned, nonuniform weight distributions generally occur with a nonuniform rigidity distribution. In the generally applied rigidity variation by corresponding dimensioning of the cross-sectional height of a bending oscillator, however, the effect of a weight increase in the region of increased cross-sectional height is of relatively less importance, because the rigidity becomes effective with a higher power of cross-sectional height as a result of the relation to cross section-surface moment of inertia. The weight increase can then often be ignored, but in any event does not generally interfere.

On the other hand, weight structure can be achieved without a significant effect on rigidity in a favorable manufacturing respect by means of elevations or recesses bounded on all sides within the vibrating surface (i.e., spot-like). For this purpose the latter can be

designed also in the form of openings of limited surface extent within a plate-like vibrating element, whereas the application of additional weight is advantageously considered for the regions of increased oscillating weight occupancy. In this fashion rigidity and weight structures can also be combined in an arrangement with mutually reinforcing effect.

Figure 5 shows a grid-like weight structure G5 extending over the surface of a plate-like vibrating element SE4 with, for example, circular regions AA1, AA2, ... of increased oscillating weight and equivalent regions BB1, BB2, ... of reduced oscillating weight. This grid distribution corresponds in basic structure to a two-dimensional structure along intersecting families of lines according to Figure 4.

For this purpose Figure 6 shows in cross section the layout of regions BB1, BB2, ... in the form of holes within the thin-walled plate element and the layout of the regions of increased weight in the form of added weight elements ZM1, ZM2, ZM3, The latter can be glued on as button-like elements of simple shape. However, the possibilities shown on elements ZM2 and ZM3 of application in the form of thin layers of a material of high density is particularly advantageous in manufacture, for which purpose heavy metals and corresponding alloys can be considered, especially noble metals. These elements can be conveniently produced in the form of sheet sections and glued on, but also applied in the form of metal-filled molding compounds or paints. The latter offers the particular advantage of manufacturing simplicity.

As an example of another main application possibility of superimposed structures Figures 7 shows a rod-like vibrating element SE5 in the form of a tuning bar within a resonance hollow element of a string instrument. The structure G6 encompasses with its crest-like or groove-like regions of increased or reduced bending rigidity A1, A2, A3 and B1, B2, B3 the periphery of the rod-like vibrating element. According to experience noticeable sound improvements can also be achieved with this type of divided coupling elements. The adjacent plate-like vibrating elements S4 of the hollow body are also advantageously provided with superimposed structures of the aforementioned type, in which excellent overall results are attainable by mutual adjustment of the structure dimensions.

The cross-sectional configuration of a stiffening rib according to Figure 8 is based on the finding that sound-relevant transverse oscillations in solids also occur in relatively compact structures, in the present case bending oscillations in different directions parallel to the cross-sectional surface. Standing waves with a longitudinal direction across the longitudinal direction of the ribs are then favored by the regions of increased or reduced bending rigidity distributed according to the superimposed structures G8a, b, c in their design according to a harmonic series. Corresponding effects can be achieved with regions or elements ED of higher density embedded in the vibrating solid according to the rib layout of Figure 9, which are arranged in the form of two superimposed structures G9a and G9b penetrating at right angles.

Figure 10 again shows a stiffening rib with edge or cross-sectional elevation structure, but with a cross-sectional height diminishing in the center toward the ends, as well as with an arc-like overall design for adjustment to a convex soundboard RB, as is common for string instruments. In addition to the edge or cross-sectional elevation structure G10a, superimposed structures G10b with wave-like or ridge-like recesses VT or elevations EH running in the direction of the rib height are provided on the flanks of the rib, i.e., with reference to the structures G8a, b in Figure 8 with a longitudinal extent of the structure displaced at right angles, i.e., in the longitudinal direction of the rib. The effect therefore corresponds to edge structure G10a, whose longitudinal extent ... [one line missing in original] ...

Figure 11 shows a superimposed structure on a flat resonance plate, as is common in pianos and organs, for example, with rib-like mounted stiffening elements AV. The structure here only extends in the direction across the ribs, whereas homogeneous conditions are present in the longitudinal direction of the ribs. For the sake of clarity the individual ribs are only designated with numbers 1 to 8 of the corresponding harmonics, which corresponds to the numerator of the distance-division ratio of the corresponding overlap sequence. The rib height and thus the stiffening effect diminishes with sequential number, which according to experience contributes to a trend of harmonic amplitudes that favors balance of the sound pattern. At any rate, this type of essentially one-dimensional structure (only in the cross-

sectional direction of the ribs) favors the formation of standing waves only in one direction of the plate.

In contrast, Figure 12 shows a soundboard top view with two penetrating superimposed structures G12a and G12b essentially transverse to it, which therefore produce overall a two-dimensional structure. The structure elements can be designed as stiffening elements or complementary, strip-like regions of reduced bending rigidity, but also as regions of increased or reduced weight occupancy. Narrow ribs or bridges have a limited stiffening effect in conjunction with comparatively wide intermediate spaces so that the weight increase connected in general with the increase in cross section predominates. In particular, dimensioning is therefore generally carried out so that the desired effect is produced. Starting from a homogeneous bending oscillator, locally concentrated stiffenings favor node formation, while corresponding weight concentrations, on the other hand, favor the formation of oscillation antinodes. Since the cross-sectional height, bending rigidity and weight occupancy are generally influenced jointly without special precautions, for example, local enlargement, corresponding differentiation must be considered, perhaps by material recesses in the region of the neutral bending zone (stiffening without weight increase) or by separation of regions of increased cross-sectional height by notches across the bending or wavelength direction (weight concentration without stiffening).

In the version according to Figure 12 the distances between the elongated regions of increased bending rigidity relative to the intermediate spaces (in their longitudinal direction), for example, stiffening ribs, are designed differently in the longitudinal direction of these regions over the extent of the structure family G12b and indeed, corresponding to a trend adjusted to the edge contour of the plate-like oscillating body. According to experience a particularly high utilization of the oscillating body distributed evenly over the entire surface is obtained on this account for the harmonic configuration of spectral distribution. Here again the variation amplitudes of the vibration parameters (rigidity or weight occupancy) are designed variable from overlapping sequence to overlapping sequence or also (as in Figure 10) (within each such sequence), preferably diminishing from the center to the ends.

Figure 13 shows as an additional example a circular loudspeaker membrane with two orthogonal weight concentration-superimposed structures G13a and G13b, for example, in the form of strip-like weight layers or inserts on or in the membrane material, perhaps in the form of paint with a metal granulate weighting. Such weight concentrations are generally easier to produce than rigidity concentrations in a membrane oscillating body.

The wind instrument tube shown in longitudinal section in Figure 14 is provided with a superimposed structure G14a running in the longitudinal direction of the tube in the form of narrow sites ES and wide sites WS rotationally symmetric to the tube axis. In contrast to solid oscillators the primary oscillating medium here is the air column right in the tube, in which sound emission can occur without participation of the tube or solid in the oscillation by propagation of advancing sound waves from the mouth of the tube outward. With respect to the nature of the primary oscillations as longitudinal standing waves, i.e., with axial air flow, the narrow sites can favor formation of regions of increased local flow rate, i.e., oscillation antinodes of sound particle velocity. The opposite holds for favoring the node sites of the sound particle velocity in the region of the broad sites of the tube cross section. Here again the sequence of narrow and broad sites according to a preferably harmonic superimposed structure permits targeted influencing of the spectrum and thus an improvement in sound pattern.

In addition, the tube, i.e., solid, can participate in influencing the sound, especially sound emission, by its own oscillations according to the oscillation states prevailing in its interior, which act as a stimulus for it. For this purpose the outer surface of the tube in the example is also provided with a superimposed structure G14b congruent to the inside surface.

At any rate the narrow sites in a sharp-edged design in the fashion of apertures can also have a significant damping effect, which can be used for special effects with respect to damping of certain spectral regions or harmonics. In the example such sharp-edged narrow sites are shown. If local damping is not desired, profile rounding or a nozzle-like configuration of the narrow sites should be preferred.

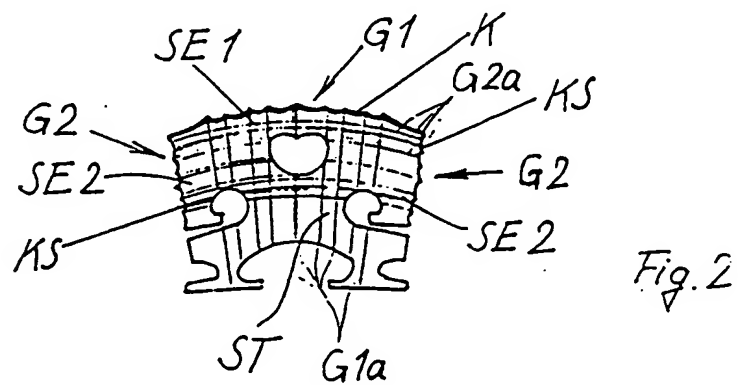
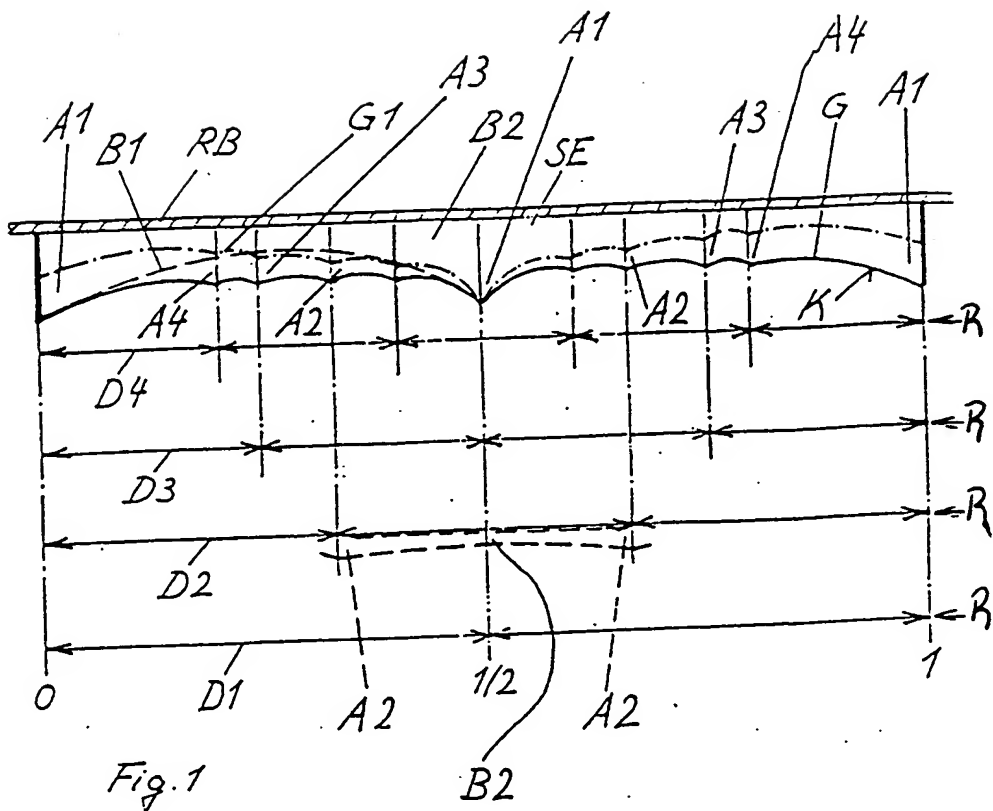
It should be noted in general that the solid walls as boundaries of the oscillating air column are under a corresponding periodically deviating internal pressure and therefore are

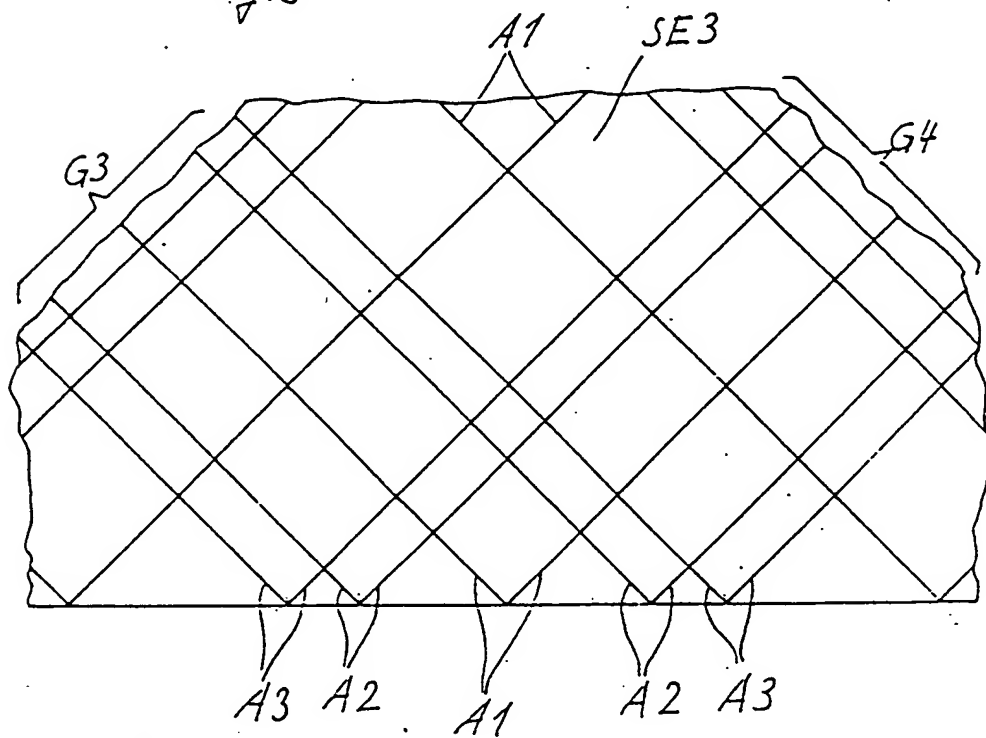
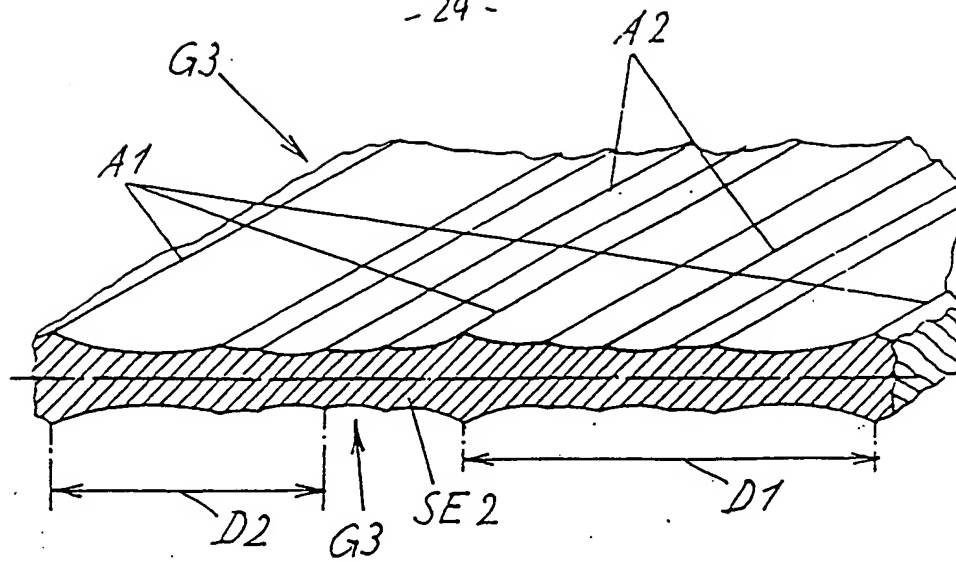
induced to transverse oscillations (in contrast to the longitudinal oscillations of the air column). This therefore produces similar conditions as in a thin-walled resonance body that transfer its transverse oscillations or standing waves to the surrounding air in the form of propagating body waves directed across the solid surface. Since the nodes of the sound particle velocity, on the one hand, and the sound pressure are displaced relative to each other (in simple ratios the nodes and antinode positions are exchanged) it can be advantageous to displace accordingly the internal and external structure with respect to weight accumulations or stiffening sites.

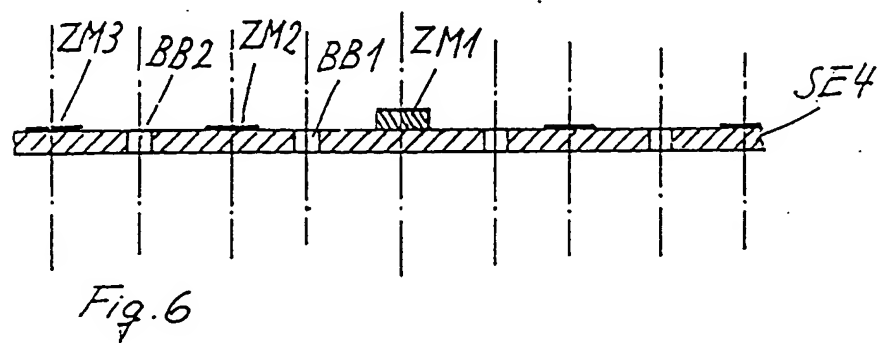
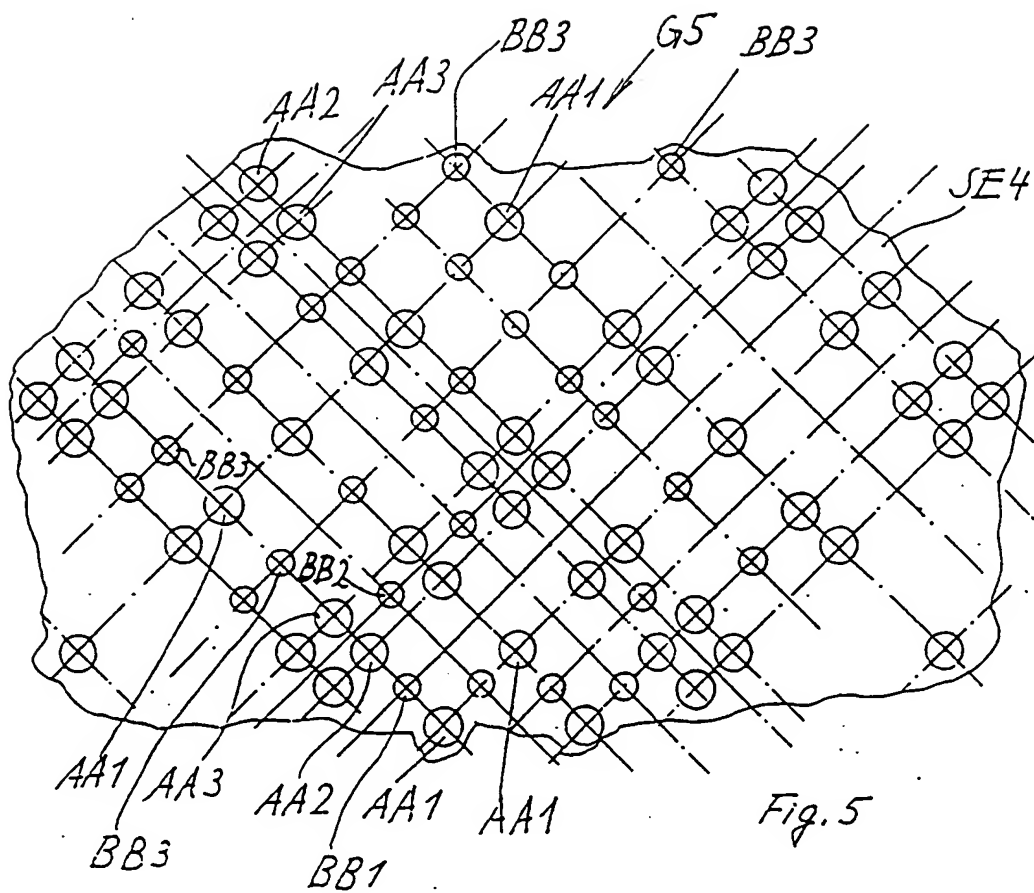
Figure 16 shows the cross section of a sound distribution space with arc-like-convex superimposed structure G16 on the floor and ceiling. The structures extend parallel to the room cross section from the center-vertical plane to both sides. A corresponding structure is also considered in the longitudinal direction of the room with reference to the sound emission side (not shown), also a corresponding two-dimensional structure or penetration of the structures in both directions.

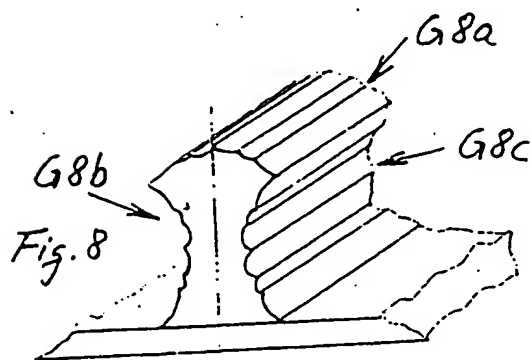
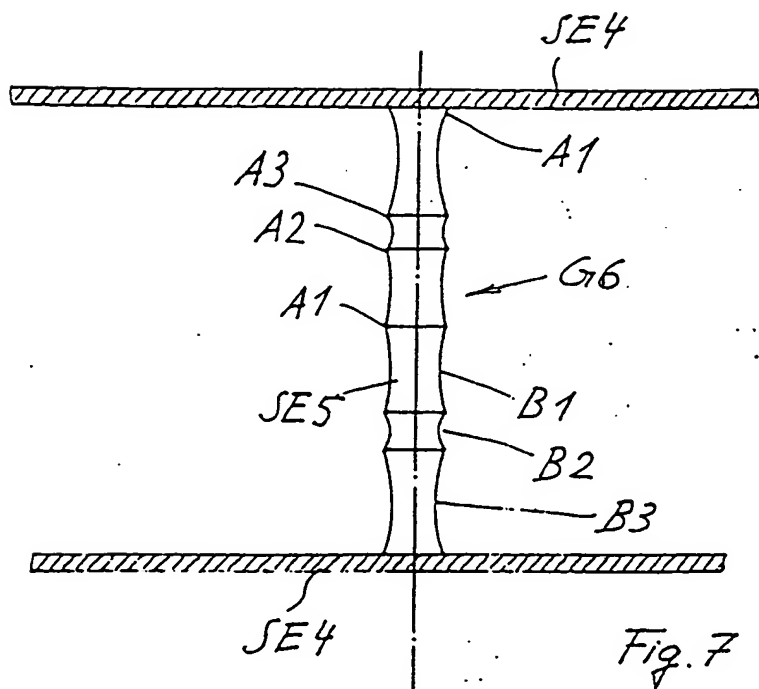
The effects attainable here are naturally not based on the formation of standing waves in the room, let alone solid oscillations with wavelengths in the region of the large dimensions or structure distances. Targeted influencing of the room sound pattern is involved here instead by means of emphasized reflection or absorption regions in which profiling in the convex regions permits equalized sound filling of the room overall by overlapping.

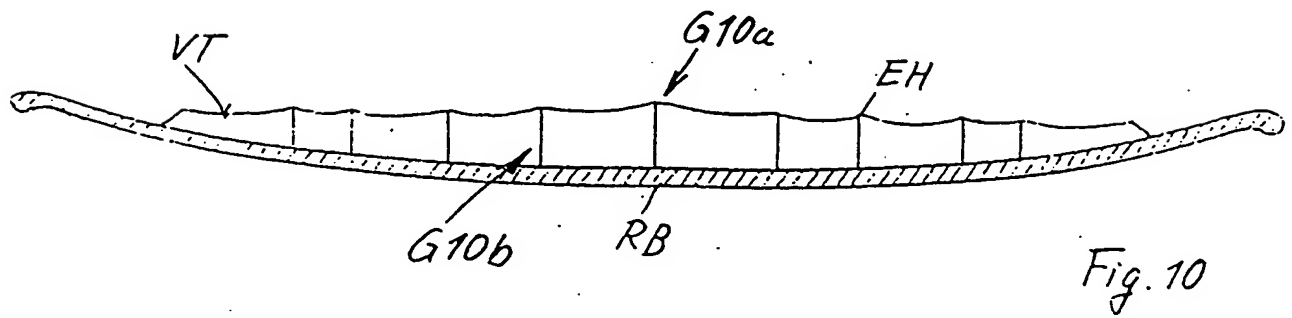
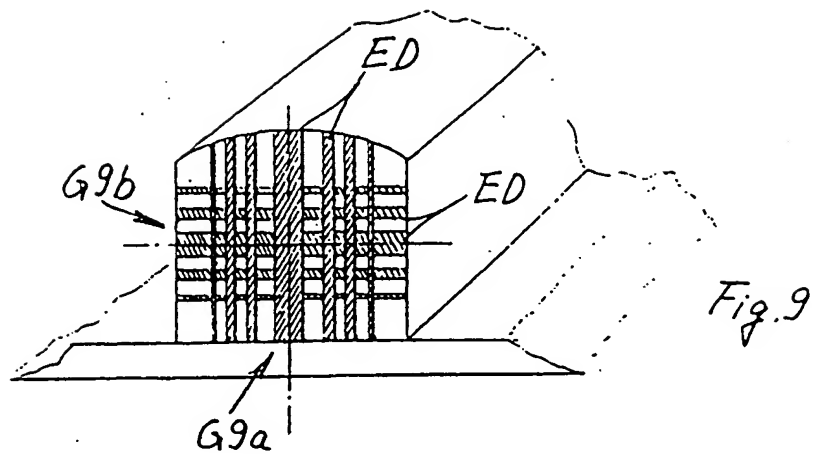
In conclusion, it should be emphasized that not only can spatial harmonic distribution of standing wave nodes be favored, but so can a similar distribution of attenuation be used for targeted sound improvement. The distribution characteristics stated for a concentrated arrangement of stiffenings or masses or narrow and wide sites are therefore applicable in analogous fashion for damping regions or damping elements. A preferred damping effect can be implemented utilizing known material properties.

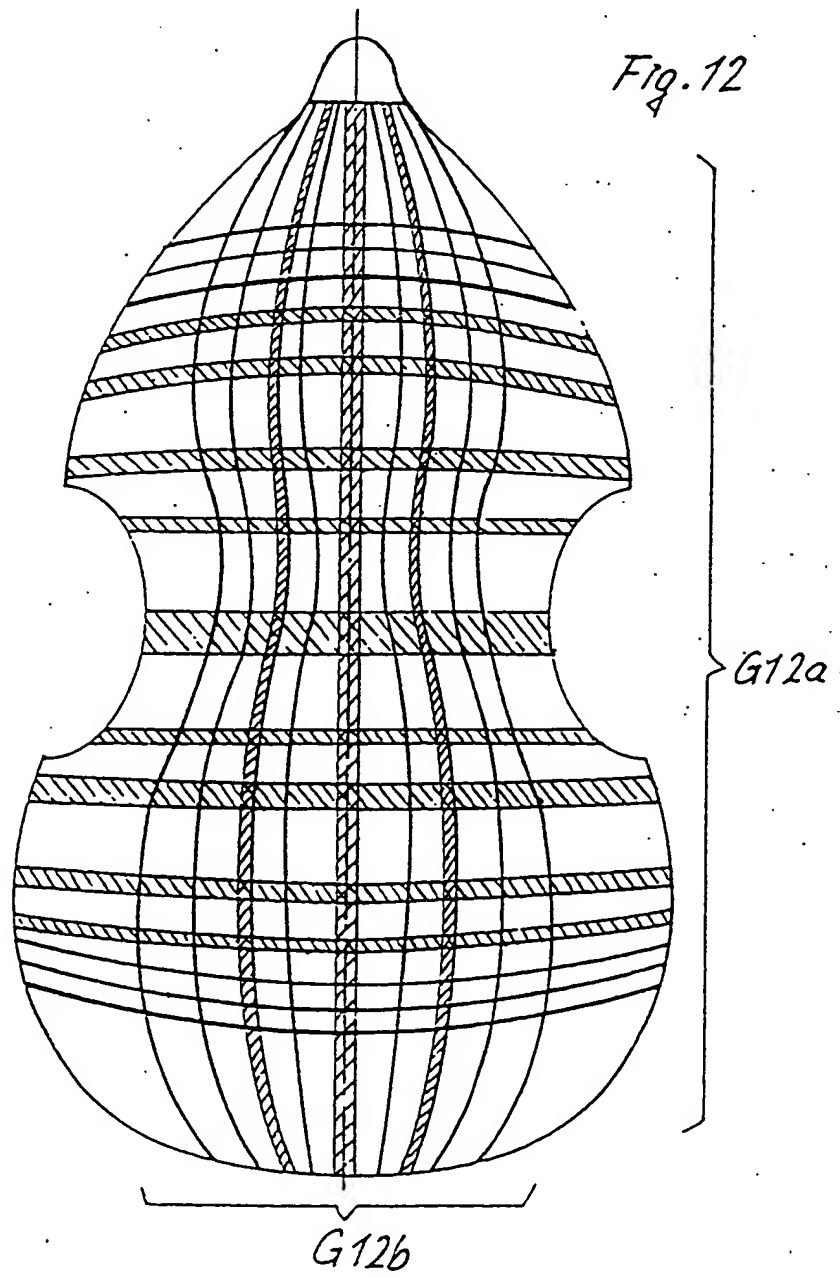
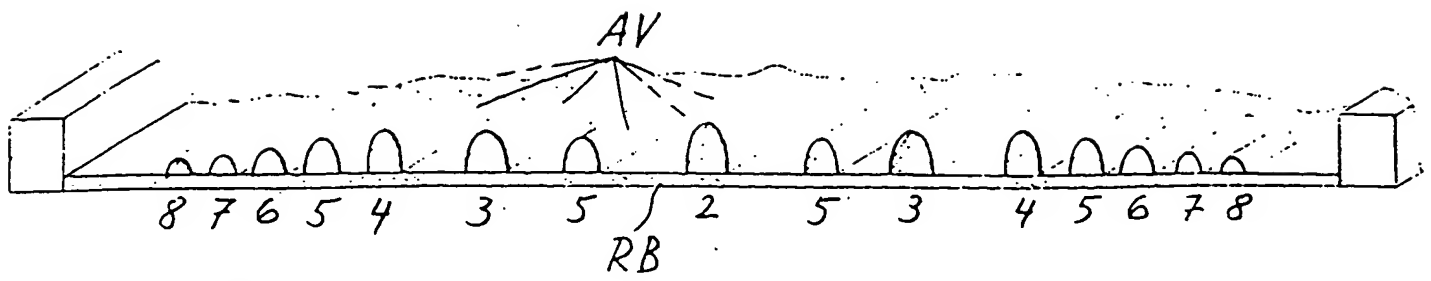


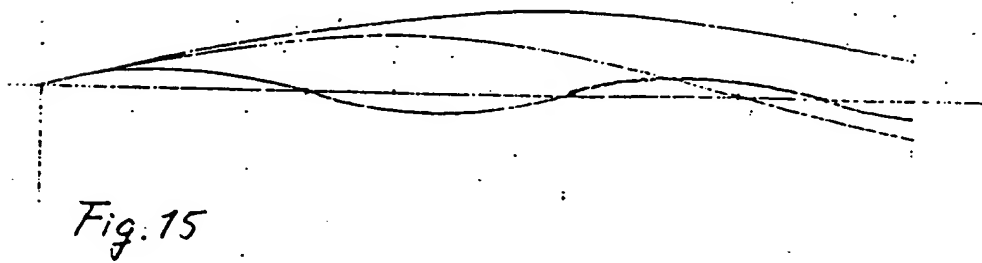
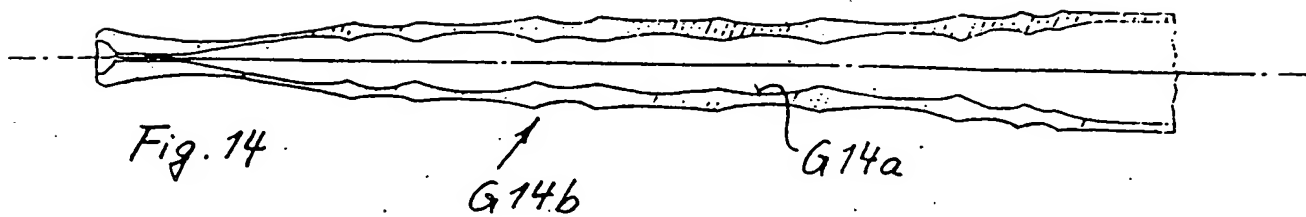
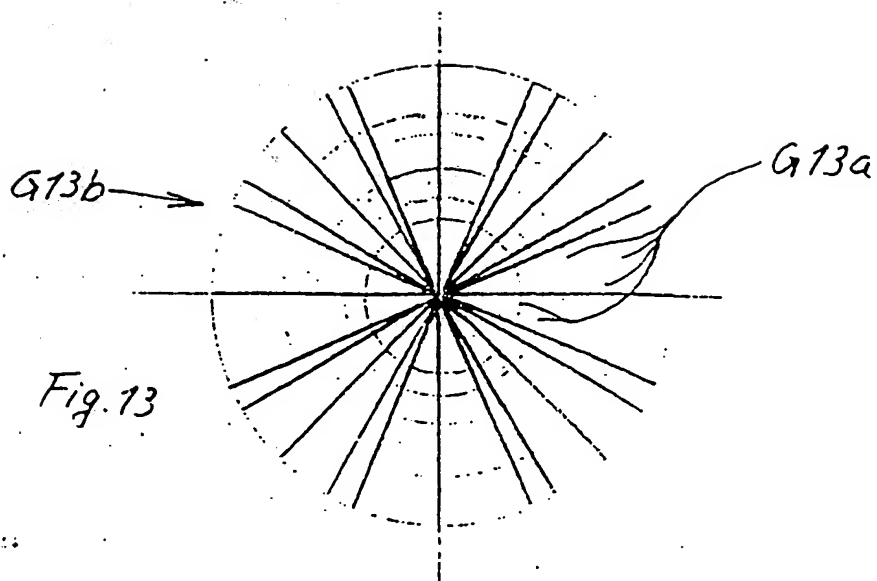












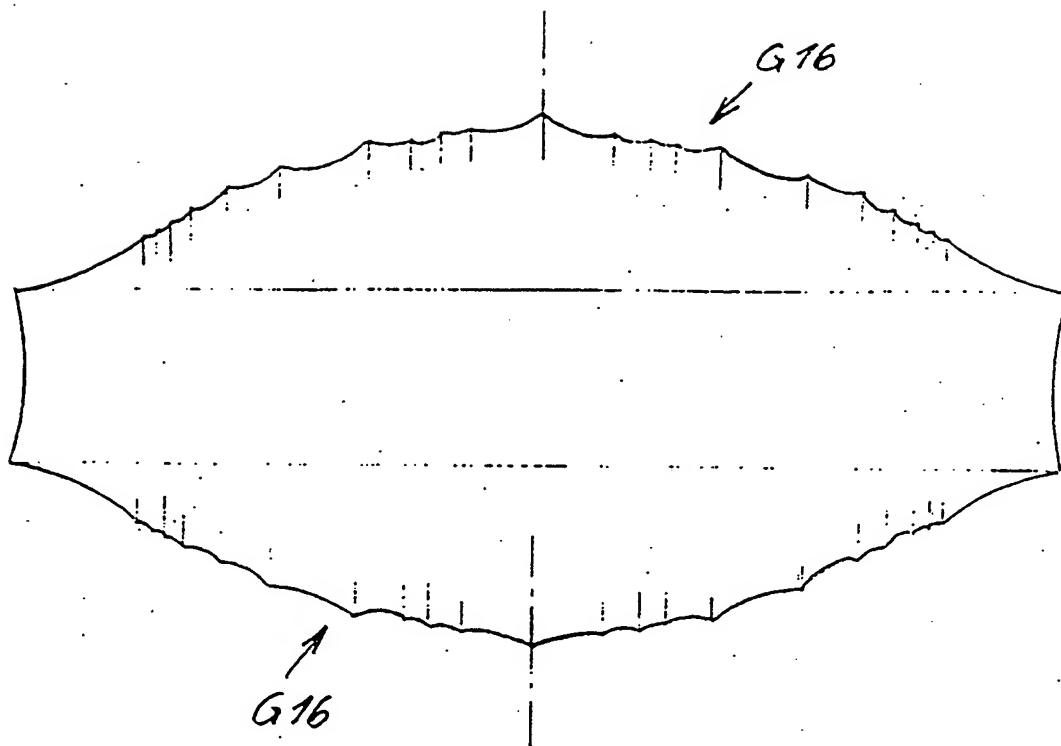


Fig. 16